CLAIMS

1. A lithographic projection apparatus comprising:

an illumination system for supplying a projection beam of radiation;

a first object table for holding patterning means capable of patterning the projection beam according to a desired pattern;

a second object table for holding a substrate having a surface to be exposed, such that, when held on the table, the said surface lies in a reference plane;

a projection system for imaging the patterned beam onto a target portion of the substrate; and

a positioning system for moving said second object table between an exposure position, at which said projection system can image said patterned beam onto said substrate, and a measurement position; characterized by:

a calibration system for measuring lateral displacements of a reference point in a plane of said second object table as a function of tilt, at said measurement position, wherein said calibration system comprises:

a diffraction grating mounted to said second object table;

illuminating means for generating a measurement beam of radiation and directing it to be incident on said diffraction grating so as to be diffracted thereby; and

a detector for detecting the position of said diffraction grating.

2. Apparatus according to claim 1 wherein said diffraction grating is an at least partially transmissive diffraction grating and said calibration system comprises a light guide for directing said measurement beam to be incident on said diffraction grating in a direction substantially independent of the tilt of said second object table.

3. Apparatus according to claim 1 or 2, wherein said calibration system is constructed and arranged for measuring displacements of a reference point in said reference plane and said diffraction grating is mounted substantially parallel to said reference plane on said second object table.

4. Apparatus according to claim 2 or 3, wherein said illuminating means is arranged to emit said measurement beam along an incident path substantially perpendicular to and spaced from said diffraction grating, and said light guide comprises a plurality of reflectors mounted

to said second object table behind said diffraction grating relative to said illuminating means and positioned to reflect said measurement beam onto a return path parallel to said incident path and passing through said diffraction grating in a direction opposite to said incident path.

5. Apparatus according to claim 4, wherein said plurality of reflectors comprises a transparent body having three mutually perpendicular faces at which said measurement beam undergoes reflection.

6. Apparatus according to claim 1, 2 or 3, wherein said illuminating means is arranged to emit said measurement beam along an incident path substantially perpendicular to said diffraction grating and passing therethrough, and said light guide comprises a retro-reflector mounted to said second object table behind said diffraction grating relative to said illuminating means for reflecting said measurement beam along a return path substantially parallel to said incident path and passing back through said diffraction grating.

7. Apparatus according to claim 6, wherein said retro-reflector comprises a plane-reflector and a condensing lens mounted at a distance substantially equal to its focal length from said plane-reflector.

8. Apparatus according to claim 7, wherein said retro-reflector comprises a solid body of transparent material having a front surface curved to form said condensing lens and a plane rear surface partly reflective to form said plane-reflector.

9. Apparatus according to claim 7 or 8, wherein said plane-reflector is sized and positioned so as to reflect substantially only the zeroth diffraction order of the measurement beam diffracted by its first passage through said diffraction grating.

10. Apparatus according to claim 9, further comprising absorbent or diffusive surfaces in the plane of said plane-reflector outside the reflecting area thereof.

11. Apparatus according to claim 6, wherein said retro-reflector comprises a corner-cube.

12. Apparatus according to any one of claims 6 to 11 further comprising an anti-reflection coating on at least one surface of said diffraction grating.

13. Apparatus according to any one of the preceding claims comprising a plurality of calibration systems for measuring displacements of said second object table with tilt about a plurality of axes.

14. A method of calibrating a lithographic projection apparatus comprising:

an illumination system for supplying a projection beam of radiation;

a first object table for holding patterning means capable of patterning the projection beam according to a desired pattern;

a second object table for holding a substrate having a surface to be exposed, such that, when held on the table, the said surface lies in a reference plane;

a projection system for imaging the patterned beam onto a target portion of the substrate; and

a positioning system for moving said second object table between an exposure position, at which said projection system can image said patterned beam onto said substrate, and a measurement position, said positioning system including electronic control means having parameters defining a rotation-invariant point of the second object table; the method comprising the steps of:

measuring the position of a reference point on the surface of the second object table at different tilts;

calculating the distance between the surface of the second object table and a rotation-invariant point of the second object table;

adjusting parameters of said electronic control means included in said positioning system so that said rotation-invariant point is at a predetermined vertical distance from the reference surface of the second object table.

15. A method of manufacturing a device using a lithographic projection apparatus comprising:

an illumination system for supplying a projection beam of radiation;

a first object table for holding patterning means capable of patterning the projection beam according to a desired pattern;

a second object table for holding a substrate having a surface to be exposed, such that, when held on the table, the said surface lies in a reference plane;

a projection system for imaging the patterned beam onto a target portion of the substrate; the method comprising the steps of:

providing a substrate provided with a radiation-sensitive layer to said second object

table;

providing a projection beam of radiation using the illumination system;

using said patterning means to endow the projection beam with a pattern in its cross section; and

moving the second object table to an exposure position, and projecting the patterned beam of radiation onto said target portions of the substrate; characterized by the step of:

detecting displacements of a reference point of said second object table at various angles of tilt when situated at said measurement position.

16. A device manufactured according to the method of claim 16.